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To John Hughes Bennett
Esq & M. D. with the kindest
regards of the Author

ON THE
ANATOMICAL RELATIONS
OF THE
BLOOD-VESSELS OF THE MOTHER
TO THOSE OF THE
FŒTUS IN THE HUMAN SPECIES.

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THE particular manner in which the blood-vessels of the mother and fœtus are arranged on the inner surface of the uterus and in the interior of the placenta, by which their contained fluids act and react upon each other and the blood of the fœtus is rendered fit for the process of nutrition, has been the subject of much discussion, and of much investigation. That the blood-vessels of the uterus and placenta communicate with each other, and that a mutual interchange of blood can readily take place between them, appears to have been the prevailing supposition among the earliest cultivators of physiological science. This opinion was afterwards strengthened by the results which Cowper,* Vieussens,† Noortwyk,‡ and others, supposed they had obtained from injec-

* The Anatomy of the Human Body. The fifty-fourth Table. 1698.

† Dissertatio de Structura et Usu Uteri Placentæ Muliebris, in Genevensi Verheyenii editione. Vieussens' observations were made on the bitch.

‡ Uteri Humani Gravidi Anatome et Historia, p. 10. 1743.

tions of impregnated uteri; and also by the details of cases in which it was believed that the blood-vessels of the foetus had been drained by profuse or fatal hæmorrhage from the mother.* Haller has adduced several arguments to show that there must be some direct vascular connection between the mother and foetus;† and Senac maintained that the uterine vessels of the mother, and the placental arteries of the foetus, poured their blood into a cellular tissue in the placenta, and that the foetal placental veins took their origin from the interior of these cells.‡ Flourens is the only author of any reputation in modern times who has alleged that there is any direct communication between the blood-vessels of the mother and the foetus; but there cannot be a doubt that this opinion is erroneous, and ought now to be totally abandoned.§

Satisfactory evidence was adduced by *Monro primus*, || the two Hunters, ¶ *Monro secundus*,** and his brother, Dr D. *Monro*, †† and by *Wrisberg*, ‡‡ that there is no vascular continuity between the blood-vessels of the mother and the placental vessels of the foetus, and this has since been most fully confirmed by the testimony of numerous accurate and careful observers.

A most important advance was made in our knowledge of the anatomical relation of the blood-vessels of the mother and foetus by the labours of the Hunters. They satisfied themselves that the umbilical arteries terminate in the umbilical veins, and not in the vessels of the uterus, and that the blood in the umbilical arteries “passes from the arteries into the veins as in other parts of the body, and so back again into the child.” They further observed, that numerous small curling arteries, the largest being about the size of a crow-quill, passed from the inner surface of

* Vide a case by Mery, *Memoires de l'Academie Royale des Sciences*. 1708.

† *Elementa Physiologiæ*, Tom. viii. p. 255–58. 1773. We are informed by Dr D. *Monro* (*Edinburgh Physical and Literary Essays*, Vol. i. p. 451, 1761,) that Haller, in a private conversation, stated to him, that subsequently to the expression of this opinion, he had examined three impregnated uteri, and found nothing like a direct communication between the uterine and foetal placental vessels, “so that he now believed that there was no such anastomosis as was alleged.”

‡ *Traité de la Structure du Cœur*, Tom. ii. p. 68. 1749.

§ *Cours sur la Generation*, p. 130. Paris, 1836. Flourens states that this communication exists in those animals only which have a *single* placenta, as in the human species, the carnivora, and the rodentia.

|| *Edinburgh Medical Essays*, Vol. ii. p. 102. Third edition. 1747.

¶ John Hunter “*On the Animal Economy*,” 1794; and William Hunter, “*The Anatomical Description of the Human Gravid Uterus and its contents*,” 1794.

** *Edinburgh Physical Essays*, Vol. i. p. 481.

†† *Idem liber*, p. 456.

‡‡ *Commentationum Medici*, &c. p. 46 and 312. 1800. See more especially his notes to the *Primæ Linæ Physiologiæ* of Haller, *Caput xxxi*.

the uterus, that they penetrated the decidua, and opened into the interstices between the fœtal blood-vessels of the placenta.* Prolongations from the uterine sinuses were also traced through the decidua, and were observed to terminate in the placenta in the same manner as the curling arteries, so that "in the umbilical portion of the placenta the arteries terminate in veins by a continuity of canal, whereas in the uterine portion there are intermediate cells, in which the arteries terminate, and from which the veins begin." It was therefore concluded, that the blood of the mother was poured by the curling arteries into a kind of cellular tissue, filling up the intervals between the ramifications of the fœtal placental vessels, from which it returns to the uterine sinuses of the mother through their placental prolongations, after having acted upon the blood of the fœtus through the thin walls of the umbilical placental vessels.

The existence of these utero-placental vessels has, however, within the last few years, been repeatedly called in question, both in this country and on the continent, and it has been asserted that the blood of the mother cannot be carried into the interior of the placenta, that the placenta is entirely a fœtal organ, and that the blood-vessels of the uterus and placenta cannot intermingle. The supporters of this view of the nature of the connection of the uterus and placenta have been Lauth, † Dr R. Lee, ‡ Velpeau, § Dr Radford, || Seiler, ¶ Ramsbotham, ** Mr Millard, †† and Mr Noble. ‡‡ From the extent and respectability of this adverse testimony, serious doubts of the correctness of the description given by the Hunters began to be entertained by many who had hitherto placed implicit confidence in it. Evident signs of a rapid return to the Hunterian views have, however, now manifested themselves, and this has been effected not only by the confidence due to the known accuracy of the Hunters, but also by the late observations of Weber, §§

* These curling arteries have been figured by Albinus (*Uteri Gravidæ*, Tab. vii); by Dr D. Monro and Monro *secundus* (*Opera cit.*); by William Hunter (*The Anatomy of the Gravid Uterus Exhibited in Figures*, plates 28, 29, and 30. 1774); and by John Hunter (*opus cit.*).

† *Répertoire Général D'Anatomie et de Physiologie*, Tom. i. p. 75. 1826. Lauth believed that the union of the uterus and placenta is effected by means of vessels, but these are lymphatics and not blood-vessels.

‡ *Philosophical Transactions for 1832*, p. 57.

§ *Embryologie ou Ovologie Humaine*, p. 63. Paris, 1833, "J'ai cherché mais en vain ces vaisseaux utero-placentaires," p. 69.

|| *On the Structure of the Human Placenta*. Manchester, 1832.

¶ *Die Gebärmutter und das Ei des Menschen*, S. 31. Dresden, 1832.

** *Medical Gazette*, Vol. xiii. p. 613, 1834.

†† *Ibid.* Vol. xiv. p. 654.

‡‡ *Ibid.* p. 810.

§§ *Hildebrandt's Handbuch der Anatomie des Menschen*. Vierter Band. S. 495, 1832.

Dr Hugh Ley,* Eschricht,† Mr Owen,‡ and others; and by the report made by Mr Mayo and Mr Stanley on the preparations of impregnated uteri contained in John Hunter's Museum.§

Though the researches of Weber and Eschricht have led them to adopt the description of the Hunters, as far as relates to the existence of the utero-placental vessels, yet their account, as we shall afterwards see, of the structure of the interior of the placenta, differs considerably, not only from the Hunters, but also from each other.

Having made these preliminary remarks, we shall now proceed to give the details of an examination of an impregnated uterus which we had lately an opportunity of making, as they appear to us to throw additional light on these intricate questions. The uterus was obtained from the body of a woman who died suddenly about the middle of March 1839, from apoplexy occasioned by inflammatory softening of the brain, while near the seventh month of pregnancy. The uterus was first opened, the foetus was then removed, and a portion of the uterus with the whole of the adhering placenta was carefully secured. The principal facts, contained in the description which I am about to give, were not made out until August 1840. On separating the adhering surfaces of the uterus slowly and cautiously under water, I satisfied myself, but not without considerable difficulty, of the existence of the utero-placental vessels described by the Hunters. After a portion of the placenta had been detached in this manner, my attention was attracted towards a number of rounded bands passing between the uterine surface of the placenta, and the inner surface of the uterus. These bands were generally observed to become elongated, thinner, and of a cellular appearance when put upon the stretch, and were easily torn across; while at other times, though much more rarely, they could be drawn out in the form of tufts from the mouths of the uterine sinuses. On slitting up some of the uterine sinuses with the scissors, these tufts could be seen ramifying in their interior, and were more or less elongated; many of them appearing only to dip into the open mouths of the sinuses, while others proceeded from a quarter of an inch to an inch from the open mouths of the sinuses by which they had entered, and in some cases they extended themselves into one of the neighbouring

* *Lancet*, 15th June 1833.

† *De Organis quae Respirationi Fœtus Mammalium inserviunt; Prolusio Academica.* Hafniae, 1837. Vide Wagner's *Lehrbuch der Physiologie*, Erste Abtheilung, S. 123, 1839.

‡ Palmer's edition of John Hunter's Works, Vol. iv. p. 67. Mr Owen in his first investigations into this subject adopted the conclusions of Dr Lee, but more lately he has seen good grounds to return to the Hunterian view.

§ *Lancet*, 22d June 1833.

sinuses. (Plate I. Fig. 1, 2.) The next point was to endeavour to ascertain the nature of these tufts by injection and microscopic examination. A size injection was thrown into the umbilical vein, and though it ran imperfectly from the injury done to the detached portions of the placenta while tracing the course of the utero-placental vessels, yet several of the branches of the tufts contained in the uterine sinuses were filled with injection, and their continuity with the umbilical placental vessels was clearly ascertained. On placing portions of these tufts under the microscope, along with portions of the umbilical vessels taken from different parts of the interior of the placenta, their identity was at once apparent. Having thus determined that these tufts observed in the uterine sinuses of the mother were prolongations of the fœtal placental vessels, I then proceeded to examine their anatomical relations to these sinuses. These tufts were found to protrude into the open mouths of certain of the uterine sinuses only, and it need scarcely be added that they were observed only in those sinuses placed next the inner surface of the uterus, and not in any of the deeper sinuses. These tufts were surrounded externally by a soft tube similar to the soft wall of the utero-placental vessels, which passed between the margin of the open mouths of the uterine sinuses, and the edges of the orifices in the decidua through which the tufts protruded themselves into the sinuses. The size of these tufts varied considerably. Some of them appeared to fill up completely the open mouths of the sinuses by which they entered; while others filled them only partially.* On examining these tufts as they lay in the sinuses, it was evident, that, though they were so far loose and could be floated about, yet they were bound down firmly at various points by reflections of the inner coat of the venous system of the mother upon their outer surface. This reflection of the inner coat of the uterine sinuses upon the tufts was sometimes observed at the point where these entered the open mouths of the sinuses, at other times it was at or near their apices, and was in general so strong that the tufts were torn across in attempting to detach them by pulling. In this uterus we thus ascertained that while some of the utero-placental veins contained no prolongations of the fœtal placental vessels, in others these passed along their interior and projected into the uterine sinuses. On tracing those utero-placental veins, which contained no fœtal vessels, as far as the placental surface of the decidua, the inner coat of the venous system was seen to be prolonged upon some of the tufts of fœtal-placental vessels in their immediate neighbourhood. On tracing one of the larger of the curling arteries through the decidua, it was also observed, that when it reached the placental surface of that mem-

* The mouths of the sinuses form rounded openings, which are much smaller than the interior of the sinuses into which they open.

brane, the inner coat of the arterial system of the mother was prolonged upon some of the tufts of the foetal placental vessels, which projected into their orifices. Those numerous branches of the foetal placental vessels, which reach the placental surface of the decidua and do not pass into the uterine sinuses, nor into the orifices of the utero-placental vessels, are attached by their apices to the placental surface of that membrane.

On placing some of the filaments, composing these tufts of foetal placental vessels found in some of the uterine sinuses of the mother, under the microscope, they were observed to divide and subdivide into branches more or less elongated, all of which terminated in blunt extremities. Fig. 3 is an exact representation of a branch of one of these tufts as it was observed through the microscope, and was taken by my friend, Mr John Goodsir, of whose very valuable testimony I have availed myself in almost all the observations I have made on this subject. Few, however, of these branches afforded so favourable an opportunity of observing their mode of termination, for they are almost always more elongated and tortuous than what is here represented, and, from being interlaced, it is generally impossible to unravel them without tearing or otherwise altering their form. A similar examination of the vessels composing the mass of the placenta showed that these presented the same anatomical characters, though, from the intricate manner in which their branches are there interlaced, without, however, having any actual attachment to each other, as they cross and recross each other, there would have been much difficulty in ascertaining this, had those found in the uterine sinuses not been first examined, since they are there in general much shorter and less interwoven than in the placenta itself.* It would be exceedingly difficult to give any exact representation or description of the arrangement of the foetal placental vessels, for the subdivisions of the larger branches are so numerous, vary so much in length and in tortuosity, and the only point which we are anxious to establish at present is, that, notwithstanding those varieties in the subdivision of their branches, they are all found to terminate in blunt extremities. There is no cellular nor any other tissue filling up the intervals left between the branches of the foetal placental vessels; and the difficulty experienced in unravelling them does not arise from the presence of any con-

* From very numerous microscopic examinations of the vessels of the placenta, I have no hesitation in saying that the representation of these vessels given in Wagner's *Icones Physiologicae*, Tab. xi. Fig. 2, and stated to have been furnished him by Weber, is far from being correct. The placental vessels have an evident resemblance to the representations of the branches of the shaggy corion, given by Raspail, (*Organic Chemistry*, Plate xiii. Fig. 9); by Ritgen (*Beiträge zur Aufhellung der Verbindung der Menschlichen Frucht mit dem Fruchthälter*, Tab. iii. Fig. 5 and 6, 1835,) and by Seiler, (*Die Gebärmutter und das Ei des Menschen*, Tab. xi. 1832.)

necting medium, but from the crossing and recrossing of the branches of different tufts, and those of the same tuft with each other. The outer surface of the placental vessels has a smooth appearance, and they are, *we may suppose*, everywhere enveloped in the inner coat of the vascular system of the mother, which, as we have seen above, is reflected upon them.

As the blood-vessels forming the placenta, and also those prolonged from it into the uterine sinuses, divide and subdivide into numerous branches, which do not anastomose with each other, but all terminate in blunt extremities, we might on theoretical grounds, as well as from the descriptions given by others, decide that in each of these branches an artery and a vein are bound up together. This conclusion was fully confirmed by the microscopic examination of some of the injected branches of the tufts of the placenta which passed into the uterine sinuses, and also of three other placentæ, in which the arteries and veins were filled with differently coloured size injection. I was satisfied that each of the smaller branches of the placental arteries is bound up with another branch of one of the placental veins, which closely accompanies it, forming what appears a single vessel when viewed through the microscope. Each branch of the umbilical artery is thus closely bound up with a branch of the umbilical veins, and both of them divide and subdivide exactly in the same manner, and terminate in what appears to be blunt extremities, but which actually form the termination of the arteries, and the commencement of the veins, Fig. 4. The interior of the placenta is thus composed of numerous trunks and branches, (each including an artery and an accompanying vein,) every one of which, we believe, is closely ensheathed in prolongations of the inner coat of the vascular system of the mother, *or at least in a membrane continuous with it*. If we adopt this view of the structure of the placenta, the inner coat of the vascular system of the mother is prolonged over each individual tuft, so that when the blood of the mother flows into the placenta through the curling arteries of the uterus, it passes into a large sac formed by the inner coat of the vascular system of the mother, which is intersected in many thousands of different directions, by the placental tufts projecting into it like fringes, and pushing its thin wall before them in the form of sheaths, which closely envelope both the trunk and each individual branch composing these tufts. From this sac the maternal blood is returned by the utero-placental veins without having been extravasated, or without having left her own system of vessels. Vide Plate I. Fig. 5. Into this sac in the placenta containing the blood of the mother, the tufts of the placenta hang like the branchial vessels of certain aquatic animals, to which they have a marked analogy. (Fig. 6.) This sac is protected and strengthened on the foetal surface of the placenta by the chorion; on the uterine surface by the *decidua*

vera, and on the edges or margin by the *decidua reflexa*.* The blood of the mother contained in this placental sac, and the blood of the foetus contained in the umbilical vessels, can readily act and react upon each other through the spongy and cellular walls of the placental vessels, and the thin sac ensheathing them, in the same manner as the blood in the branchial vessels of aquatic animals is acted upon by the water in which they float. According to this view of the structure of the placenta, the foetal and maternal portions of the placenta are everywhere intimately intermixed, and we find tufts of minute placental vessels with their blunt terminations, lying immediately under the corion covering its foetal surface, as well as towards its uterine surface. When the fissures dividing the placenta into lobes are so deep as to intersect the whole thickness of the placenta, we may have two or more of these sacs instead of one. The discovery of the prolongations of the foetal placental vessels into some of the uterine sinuses is principally valuable, as it presents us with a kind of miniature representation of the whole structure of the placenta, Fig. 1 *a*, and enables us to comprehend it readily, for we have there the foetal blood-vessels, resembling branchial vessels, ensheathed in the inner coat of the vascular system of the mother, and bathed in the maternal blood. The placenta is therefore not analogous in its structure to the lungs, but to the branchial apparatus of certain aquatic animals.

It may at first appear remarkable, that, if tufts of the placental vessels are prolonged into the uterine sinuses, these are not observed projecting from the uterine surface of the placenta when it has been expelled from the uterus in an accouchement. This, however, is explained by the fact, of their being so strongly bound down by the reflection of the inner coat of the uterine sinuses, that they are torn across. As hæmorrhage does not occur from vessels of this size when torn across, we can also explain how fine injections thrown into the placental vessels do not flow from their broken extremities, and how, in certain cases where the placenta and child have been expelled together, and where the circulation through the placenta was allowed to proceed for some time, the blood did not escape at its uterine surface. In a uterus obtained from a woman who died 24 hours after delivery, and which I had an opportunity of examining through the kindness of Professor Simpson, I observed that, while part of the mouths of the

* We have no hesitation in following William Hunter in regarding the membrane on the uterine surface of the placenta as the *decidua vera*, notwithstanding all the assertions by Velpeau to the contrary. We have in our possession a preparation of a uterus at the fifth week of utero-gestation, where a thick layer of the *decidua* evidently intervenes between the shaggy corion surrounding the ovum, and the inner surface of the uterus; and it was also observed that some of the tufts of the shaggy corion had insinuated themselves into openings in the decidua.

uterine sinuses were blocked up with coagula, a considerable number of them were empty. In those which were empty I could detect no tufts, while in those filled up with the coagula I distinctly observed several tufts of placental vessels enveloped in the coagula, when they were placed under the microscope and broken up.

In detaching the placenta from the uterus, the strongest points of adhesion were found at the place where the tufts were bound down by the reflection of the inner coat of the uterine sinuses, and it is possible that, in some cases, unnatural adhesions of the placenta may be caused by these tufts undergoing the cartilaginous degeneration, and not only be rendered stronger themselves, but also cause a thickening of the membrane reflected upon them.*

I regret that I have not had an opportunity of verifying these observations upon other impregnated uteri, for in the various quarters in which I have made inquiries after such preparations, I have hitherto been unsuccessful in procuring one.†

It appears to have been a common theoretical opinion, during the first half of the 18th century, that the fœtal placental vessels passed through apertures in the membrane placed on the uterine surface of the placenta (then generally termed chorion), and fixed themselves in orifices in the inner wall of the uterus. Brendel ‡ describes the radicles of the chorion as implanting themselves in the inner surface of the uterus, in the same manner as a plant fixes itself in the soil, and in this manner forms blood-vessels which take up a nutritious lymph, which they receive from the maternal vessels of the uterus. Trew§ also describes the filaments of the placenta as proceeding into the substance of the uterus. Rouhault || describes the membrane on the uterine surface of the placenta as “percée dans toute son étendue pour laisser passer les racines des vaisseaux ombilicaux, qui vont ou qui viennent de toutes les parties de la matrice par un nombre innombrable de petits trous.” That this description does not refer to the fœtal placental vessels passing into the uterine sinuses which we have above described, but to certain imaginary vessels, is still further evidenced by the statements contained in another paper by the same author, where the membrane on the uterine surface of the placenta is said to be

* In a placenta containing some cartilaginous masses, into which I had thrown a fine injection, I observed on unravelling one of these after it had been macerated for some days in water, that the injection had only entered the larger trunks of the vessels, and that all the smaller ones were impermeable, and had the colour and consistence of the cartilaginous mass itself, which was in fact entirely composed of them.

† It is quite possible that these tufts do not generally project so far into the interior of the uterine sinuses as in the uterus we have examined.

‡ *De Nutritione Fœtus in Utero*, published in 1704, reprinted in Haller's *Disput. Anatom. Select.* Tom. v. p. 488.

§ *De Chylosi Fœtus in Utero*, published in 1715, reprinted in Haller's *Disput. Anat.* Tom. v. p. 445.

|| *Memoires de L'Academie Royale des Sciences* for 1716, p. 343.

pierced by a *million* of small holes, each of which is filled up by as many small capillary blood-vessels.* Vater,† proceeding on the supposition which we have seen to be common at the time he lived, viz. that the ovum, after exhausting the nutriment which it found in the uterus, sends the filaments of the chorion into the substance of the uterus as a plant shoots its roots into the soil, and being also aware of the existence of the open mouths of the uterine sinuses, states, that the vascular extremities of the chorion insinuate themselves into the *open mouths of the uterine sinuses*, and draw nourishment from them. We find no evidence which would lead us to believe that this description given by Vater was not a mere expression of a theoretical opinion. Noortwyk‡ describes numerous vessels emerging from the uterine surface of the placenta, inserting themselves into the uterine pores, and forming a manifest communication between the blood-vessels of the mother and foetus. He afterwards states that these vessels are not continuations of the capillary vessels of the placenta, but vessels “*omnino sui generis.*”§ Monro *primus*,|| after maintaining that the placenta is covered on the uterine surface by a fine membranous continuation of the chorion, states, that “the extremities of the umbilical vessels pierce this membrane, and show their very small orifices on the side next to the uterus, and therefore it is compared to the villous coat of the intestines.” J. G. D. Michaelis¶ describes the foetal placental vessels penetrating the decidua, and passing into the walls of the uterus. He further adds, that some of them “*ad vasorum uterinorum orificia lateralia quasi agglutinatae firmiter sese applicant.*” We have thus seen that a theoretical notion prevailed for a considerable time, that the foetal vessels passed through minute and numerous orifices in the decidua; that it was then also generally believed that they entered into small openings in the inner surface of the uterus; and that one author made the fortunate guess that they passed into the open mouths of the uterine sinuses.**

It will be at once apparent to those who are familiar with the subject, that the view here given of the anatomical relations of the blood-vessels of the mother to those of the foetus is considerably different from that proposed by the Hunters, and by those who have succeeded them. The Hunters were not aware that the foetal placental vessels are prolonged into the uterine sinuses of

* Idem liber, 1714, p. 182.

† De Utero Gravido, published in 1725, Haller's Disput. Anat. Tom. v. p. 260.

‡ Uteri Humani Gravidi Anatome, &c. p. 10, 1743.

§ Idem liber, p. 14.

|| Edinburgh Medical Essays, Vol. ii. p. 102, 1747.

¶ Dissertatio Inauguralis, Med. De Placenta Humana. The date of this dissertation was obliterated in the only copy which I have seen, but the author was born in 1756.

** It is quite possible that this idea may have been repeated by other authors, of whose works I am ignorant.

the mother ;* and they believed that the intervals between the fœtal placental vessels were filled up by a cellular tissue, into which the maternal blood is poured,—an opinion which has been adopted by many on their authority, and has lately received the sanction of Mr Owen.† This cellular structure of the placenta is described by William Hunter as being formed by processes of the decidua, prolonged everywhere in the substance of the placenta, “ shooting out into innumerable floating processes and rugæ, with the most irregular and most minutely subdivided cavities between them that can be conceived ;”‡ and he further adds, that the decidua constitutes the uterine portion of the placenta, and forms a number of cells like the *corpora cavernosa penis*, communicating freely with each other.§ Eschricht|| supposes that the utero-placental vessels divide and subdivide in the placenta like the arteries and veins in other parts of the body. The description which approaches nearest to ours is that given by Weber,¶ but they differ in what I conceive to constitute some of its leading peculiarities. Weber denies that the fœtal placental vessels extend beyond the decidua.** He states that the inner coat of the venous system of the mother is prolonged into the placenta, but he describes it as ramifying in the intervals of the placental tufts, in the form of large venous sinuses, upon the walls of which the placental tufts are not only ramified, but also project into their interior, carrying the walls of the sinuses before them. He compares the bronchial tubes of the lungs to the ramifications of the utero-placental vessels in the placenta, and those of the fœtal placental vessels to the pulmonary vessels, with this difference, that the utero-placental vessels do not subdivide into numerous small branches like the bronchial tubes, but form large and wide canals.†† Wagner in a late work appears to adopt Weber’s views, and describes the utero-placental blood-vessels as winding in an expanded net-work around the tufts of the chorion containing the vessels of the embryo, and this net-work, he says, is formed of peculiar but very delicate tubes, of large calibre, especially in the case of the veins.‡‡

Note.—The transverse sections of the uterus and placenta in my possession have been examined by many who have paid attention to this subject, among whom I may

* “ It is evident that the umbilical injected vessels do not reach even the outer surface of the placenta, but are only seen through a membrane (decidua) which covers all that surface.” William Hunter, opus cit. p. 42.

† Opus cit. p. 69.

‡ Opus cit. p. 43.

§ This description of the maternal part of the placenta appears to have been adopted by Meckel, (Manuel d’Anatomie Gen. et Descrip. Tome iii. p. 764), Burns, (Principles of Midwifery, 7th edition, p. 189), and many others.

|| Opus cit.

¶ Hildebrandt’s Anatomie des Menschen. Vierter Band, S. 495.

** “ Der Uterustheil ist der an dem Mutterkucken anliegende Theil der Tunica Decidua Vera, in welchen sich die Flocken des Fœtustheils der Placenta nicht erstrecken.” S. 495.

†† Opus cit. p. 500. ‡‡ Lehrbuch der Physiologie, Erste Abtheilung, S. 123. 1839.

mention Professors Alison, Allen Thomson, and J. Y. Simpson ; and they have all expressed themselves satisfied that the placental tufts were prolonged into the uterine sinuses, and that the inner coat of the veins was prolonged upon them. I have just learned from Professor Sharpey, who was so kind as to examine, at my request, two preparations of impregnated uteri in his possession, that in one of these, which had apparently arrived at the full period of utero-gestation, and was in a condition more favourable for examination, he distinctly observed the placental tufts projecting into the mouths of the uterine sinuses.

Explanation of Figures, Plate I.

Fig. 1. *Diagrammatic sketch of a transverse section of the uterus and placenta.* a and b. Uterine sinuses, with tufts of foetal placental vessels prolonged into them. c. A curling artery passing through the *decidua vera*. c. *Decidua vera*. e. Tufts of placental vessels.

Fig. 2. *Actual representation of a uterine sinus containing tufts of foetal placental vessels.* a. *Membrana decidua vera* turned up from the inner surface of the uterus. c. Walls of uterus. b. Tufts of placental vessels in uterine sinus. d. Walls of uterine sinus which have been cut through and laid back. e. Opening in the decidua, through which the placental vessels passed into the sinus. g. Opening through which other tufts passed into the same sinus.

Fig. 3. *Actual representation of one of the branches of a tuft removed from one of the sinuses, as seen through the simple microscope.*

Fig. 4. *Artery and vein included in each branch of a tuft.* a. Artery. b. Vein.

Fig. 5. *Diagram to illustrate the views here given of the structure of the placenta.* a. Curling artery. b. Uterine vein. c. Placenta. d. Placental tufts, with inner coat of vascular system of the mother enveloping them.

Fig. 6. *Illustration of the branchial vessels of some aquatic animals.* a. Artery. b. Vein.

On some points in the Anatomy of the Medulla Oblongata.

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SINCE the brilliant discoveries of Sir Charles Bell have disclosed to us that the motor nerves are attached to the anterior portion, and the sensiferous nerves to the posterior portion of the spinal chord, the anatomical relations of the different tracts of this division of the central organs of the nervous system has assumed an interest and importance to which it had hitherto been a stranger. If we adopt, however, any of the views of the anatomical relations of the different tracts of the spinal chord, as they pass through the *medulla oblongata*, which are given in the anatomical works of this country, there appears to be some blending of the motor and sensitive tracts at that part which cannot be explained ; for, while the hypoglossal and abducens nerves arise in the line of the anterior roots of the spinal nerves, we find other motor nerves, such as the *portio dura*, the motor part of the fifth pair, the trochleator, some of the filaments of the *par vagum*, and the spinal accessory, all arising from points posterior to this, and more in the line of the origin of the posterior than of the anterior roots of the spinal nerves.

The following remarks contain an attempt, founded on repeated anatomical examination, to solve this difficulty. In speaking of the different columns or tracts of the spinal chord, we shall first consider each symmetrical half as consisting of four different columns. There are, 1. the *pyramidal* column, or that connected with the pyramidal body; 2. the *olivary* column, or that connected with the olivary body; 3. the *restiform* column, or that column occupying the lateral surface of the spinal chord between the lateral grooves to which the anterior and posterior roots of the spinal nerves are attached, and after forming the greater part of the restiform body, proceeds upward through the *pons Varolii* to the *crus cerebri*; 4. the *cerebellar* or *posterior* column placed between the posterior lateral groove to which the posterior roots of the spinal nerves are attached, and the posterior longitudinal groove, and which forms the posterior pyramidal body, and posterior part of the restiform body, and passes entirely into the *crus cerebelli*. We shall also speak of each symmetrical half of the spinal chord, as being divided into three columns, as this is a division frequently adopted. Under the *anterior* column, we shall include both the pyramidal and olivary columns; the restiform will be the *middle* or *lateral* column; and the cerebellar will be the *posterior* column. Though the position of the anterior and posterior peaks of the cineritious matter of the chord may serve as a good anatomical division of the spinal chord through a great part of its extent, the anterior peak corresponding to the attachment of the anterior roots, and the posterior peak to the posterior roots of the spinal nerves; yet, as we approach the *medulla oblongata*, it begins to fail us, and we there find the anterior peaks of the gray matter project decidedly in front of the origin of the anterior roots of the spinal nerves.

On tracing the pyramidal columns from the lower margin of the *pons Varolii* downwards to the well known *decussation* at the lower end of the pyramidal bodies, the greater part of the fibres composing these columns arrange themselves into two or more bundles, which decussate or cross each other. These decussating fibres cross the bottom of the anterior longitudinal fissure, and proceed downwards and backwards to join the posterior part of the restiform or middle columns, which they accompany in their course downwards, (Plate II. Fig. 1 and 2.) Every one may readily satisfy himself that none of these decussating fibres proceed into the anterior column of the opposite side, but follow the course we have mentioned, by making a slightly oblique division of the spinal chord at the point of decussation, or by tearing down the pyramidal columns in brains rendered firm by immersion in alcohol, and carefully observing the course which they take. While the greater part of the fibres of the pyramidal columns decussate in the manner we have mentioned, a much smaller number of the ex-

ternal fibres of each column do not decussate, but proceed downwards on the same side, and, along with the olivary column, form the anterior column of that side of the spinal chord. In a small number of the numerous dissections we have made, the whole of the pyramidal column appeared to pass into the middle column of the opposite side. A band of the fibres of the pyramidal column, which in some cases are very distinct, curve round the lower part of the olivary body of the same side, and then proceed upwards and backwards to join the posterior or cerebellar column, as it passes into the *crus cerebelli*, (Fig. 4.) This band of fibres, figured by Santorini, and Gall and Spurzheim, described by Rosenthal,* Rolando, and more lately by Mr Solly, has been termed the *arciform* filaments or band. The filaments forming this arciform band do not decussate. In a preparation in my possession, (Fig. 4,) in which this arciform band is unusually strong, it is distinctly observed to divide itself into two parts, one of these, the larger, follows its usual course to join the posterior column, the other throws itself into the olivary column, (Fig. 4, b.) and proceeds downwards along with it. On tracing the olivary columns downwards, they are observed to converge at the lower part of the pyramidal bodies, and below the decussation they are only separated from each other by the longitudinal fissure, and the small band of the pyramidal column which proceeds downwards without decussation, (Fig. 5.) At the upper part of the *medulla oblongata*, the olivary bodies are thus thrown apart by the thick bands of which the pyramidal columns consist at that part; while below the decussation the greater part of the pyramidal bodies have now passed backwards to join the middle or restiform columns, and the olivary columns are consequently thrown forwards, and compose the greater part of the anterior columns. On tracing the olivary column upwards, we observe that, after having surrounded the olivary body which lies among its fibres like a kernel, it passes into the *pons Varolii*, and there divides itself into two bands, which diverge from each other, one of them proceeding upwards and forwards to join the *crus cerebri*, the other proceeding upwards and backwards to reach the *corpora quadrigemina* or optic lobes, (Fig. 6.)† On scraping off the cineritious matter from the floor of the fourth ventricle, and drawing the upper part of the posterior column aside by widening the posterior longitudinal groove, or, what will answer better, by de-

* Ein Beitrag zur Encephalatomie, S. 28. Rosenthal describes this as a marked medullary layer passing from the pyramidal bodies over the inferior parts of the olivary bodies to the *posterior column*, and thus forming a strong bond of union to these parts, which varies in strength and thickness in different cases.

† Rolando and Mr Solly (The Human Brain, &c. p. 148-49,) deny the existence of this olivary tract; but this appears to us a point about which no doubt can be entertained.

taching one of the posterior columns at this part, (Fig. 3,) we obtain a posterior view of the decussating fibres of the pyramidal columns already described, as they pass into the posterior part of the middle columns. If we were restricting our examination to this surface alone, we might be led to believe that the decussating fibre brought into view formed a decussation between the two middle columns, and it has been described as such.* No doubt, if we describe the middle column as proceeding from below upwards, as is now most frequently done, it may be justly said that this is a decussation of part of the fibres of the middle column; but then it ought to be added, that these decussating fibres do not pass into the middle column of the opposite side, but into the pyramidal column of the opposite side. After the most careful search, we have not been able to find any other decussation besides that we have mentioned. With these remarks upon the anatomy of the *medulla oblongata*, we now proceed to point out the attachments of the various nerves to the different columns. We have stated above, that the olivary columns converge towards each other at the lower part of the pyramidal bodies, in consequence of the greater part of the pyramidal columns passing backwards to join the middle lateral columns. If we trace these olivary columns downwards, we observe that they afford attachments to the anterior roots of the first and second cervical nerves, (Fig. 5,) and that they continue their course onwards in the line of the other anterior roots of the spinal nerves. We can then have little difficulty in arriving at the conclusion, that the olivary is a motor column. On tracing this column upwards, (Fig. 6,) we find that where it embraces the olivary body, the *portio dura* is attached to its outer margin, and the hypoglossal and abducens nerves are partly attached to its inner margin, and partly to the outer margin of the pyramidal column. On tracing the two roots of the fifth pair, the smaller or motor root can be followed to that portion of the olivary column which proceeds to the optic lobes,—sometimes running down the outer or external edge of the pons to reach the portion of the olivary column already mentioned, as it immerses from the external margin of the pons, at other times its course is obscured by a greater or less number of the transverse fibres of the pons crossing it. The trochlear nerve is attached to the internal margin of the same band of fibres when it has ascended the *processus a cerebello ad testes*, and is about to enter the optic lobes. The larger or sensiferous root of the fifth, on the other hand, proceeds downwards, and passes beneath a thick mass of the transverse fibres of the pons to reach the middle or restiform column, to which it is un-

* The Nervous System of the Human Body. By Sir Charles Bell, p. 218, 1836.

doubtedly attached ; and to this same column the whole of the fibres of the glosso-pharyngeal, and nearly all the fibres of the *par vagum* are attached. In those cases where the arciform filaments are well marked, (Fig. 4,) we have observed a few of the filaments of the *par vagum* attached to them as they cross the middle column, and it is probable that the few motor filaments contained in this nerve are derived from this source. The filaments of the *par vagum* are certainly not connected with the olivary bodies, and these cannot be the ganglia of these nerves, as Mr Solly has supposed.*

With regard to the origin of the spinal accessory nerves, I find it a more difficult matter to speak with precision ; but there can be no doubt that the decussating fibres between the pyramidal and middle columns run down in the course of the spinal accessory, and we can easily imagine how the filaments of this nerve could reach these decussating fibres.

It would be an interesting point to ascertain the functions of these decussating fibres, but this, from their position in the cranium, would be a matter of great difficulty. Their connection with the root of the spinal nerves is not sufficiently obvious to enable us to draw any decisive conclusions regarding their function ; and though we have described them as proceeding from the pyramidal to the middle columns, yet we may perhaps with equal justice describe them as proceeding from the middle to the pyramidal columns. In two kittens deprived of voluntary motion and sensation by a dose of prussic acid, I observed extensive muscular movements on irritating the upper part of the pyramidal bodies with the point of a needle ; but whether these belonged to the class of excito-motory movements of Dr Marshall Hall, or whether they resulted from the impression being conveyed outwards directly to the muscles moved, I could not determine. If it should be afterwards ascertained that this is an excito-motory column, it might open up a new field of investigation.

Though the decussation at the lower part of the pyramidal bodies in even all the late anatomical works of this country is still considered as a decussation merely between the two anterior columns, yet it appears that it was correctly described by Fr. Rosen-

* Opus cit. 146-47-48. Mr Solly adduces in favour of this view the "amazingly developed" *corpora olivaria* of the porpoise, (p. 101.) In this, however, we very strongly suspect he is mistaken, for while dissecting the brain of a porpoise, we carefully looked for these large *corpora olivaria*, and could not observe them. We have also heard urged in favour of this view, the statement made by Tiedemann in his work on the fetal brain, that the *corpora olivaria* are imperfectly developed at the sixth month,—a period at which there is no use for these nerves. Whether this argument ought to be considered legitimate or not, we need not inquire ; but we have two preparations in our possession procured from fœtuses, where we had undoubted evidence that neither of them had passed the sixth month of utero-gestation, and in both, the *corpora olivaria* are very prominent, and relatively as well developed as in the adult.

thal in 1815.* He states that the pyramidal bodies ascend as a small column at the sides of the anterior fissure of the *medulla spinalis*; that they become thicker and broader at the extremity of the olivary bodies; and that "the sudden increase of its fibres is caused by the accession of small bundles which arise deeply from the large posterior fasciculus of the great column. It is these small bundles which decussating become interwoven with each other, so that several of those of the left side actually pass into the fibres of the right pyramidal body, and *vice versa*." Cruveilhier† states, that the anterior pyramidal bodies are certainly not formed by a continuation of the anterior column of the spinal chord, but by fibres from the lateral columns. Arnold's‡ description of the decussating fibres does not differ essentially from that of Rosenthal.

Explanations of Figures, Plate II.

Fig. 1. *Oblique section of spinal chord at the decussation of the pyramidal columns.* a. decussating fibres. b. posterior column. c. middle column.

Fig. 2. *Anterior view of decussation.* a. external fibres of pyramidal column detached and thrown outwards. b. decussating fibres running into posterior part of middle column. c. posterior columns.

Fig. 3. *Posterior view of decussation.* a. posterior column of one side detached and thrown upwards. b. posterior column of opposite side in its natural position. c. mass of efferent matter. f.f. decussating fibres.

Fig. 4. a. a. Arciform filaments of medulla oblongata.

Fig. 5. a. a. Anterior roots of spinal nerves. b. spinal accessory nerve. c. par vagum. d. glosso-pharyngeal. e. portio dura. f. abducens oculi. g. hypoglossal. h. 5th pair. i. olivary column. k. decussation of pyramidal columns.

Fig. 6. a. a. a. Olivary column. b. anterior root of first spinal nerve. c. hypoglossal nerve. d. abducens nerve. e. portio dura. f. smaller root or motor part of the fifth pair. g. trochlear nerve.

Appendix to Paper on the Anatomical Relations of the Blood-vessels of the Mother to those of the Fœtus.

I have had to-day an opportunity of examining an impregnated uterus, through the kindness of the Curators of the Museum of the Royal College of Surgeons here, and I beg to add the results of that examination as an appendix to my paper on the Relations of

* Ein Beitrag Zur Encephalatomie, Weimar, 1815.—When exhibiting the preparations from which the above description was drawn up, to Dr Sharpey while on a visit to Edinburgh last autumn, he informed me of the nature of Rosenthal's work, and kindly sent me his copy for perusal.

† Anatomie Descriptive, Tome iv. p. 594. Paris, 1835.

‡ Bemerkungen über den Bau des Hirns und Rückenmarks, &c. Zurich, 1838. S. 30. In his *Tabulæ Anatomicæ Fasciculus*, i. Tab. ix. Fig. 1, he represents the pyramidal bodies as being formed entirely by fibres from the lateral column.

the Blood-vessels of the Mother and Fœtus. It was apparently between the fourth and fifth months of pregnancy, and had been preserved for a long time in spirits. It had been cut open in front to show the interior, and in doing this a section had been made of that part of the uterus to which the placenta adhered. To avoid injuring the preparation, I examined only it along the cut edge. I found that an injection had been thrown into the uterine arteries, which only partially filled them. The veins were not injected. Several of the *curling arteries* were well filled with injection, while others contained only a small quantity. On tracing these from the inner surface of the uterus through the decidua, they were observed to terminate among the tufts of the placenta, without undergoing any change in their calibre during their oblique course through the decidua. The injection filled up the intervals between the tufts of the placenta in the immediate neighbourhood of the point of termination of each. These curling arteries were not continued into the placenta in the form of a tube or dilated vessel, as has been represented; but, from the manner in which the tufts adhered to their edges, we believe that the inner coat was reflected upon them, as we have already stated. On examining the utero-placental veins, the tufts of the placenta were in many cases observed to project into their open mouths, and to adhere to their inner surface, but in none that were examined did they project so far as the uterine sinuses. It is possible that if the dissection could have been carried farther, that they might have been found to project along the veins to a greater extent at some other points. In the uterus in my own possession, the tufts in numerous cases projected only into the mouths of the utero-placental veins, while in many others they extended themselves as far as the mouths of the uterine sinuses, and even projected to a considerable distance into their interior. In all these different relations of the placental tufts to the utero-placental veins, the inner coat of the vascular system of the mother is, as far as I have observed, reflected upon the outer surface of these tufts. It is very probable that the placental tufts may project into the utero-placental veins to different distances in different cases, and it may be to a greater extent in the advanced periods of utero-gestation, than at an earlier period. I am the more inclined to adopt this opinion, as it has been suggested to me, not only by the result of this examination, but also by a communication from Dr Sharpey. However this may be, it does not affect the views which I have advanced regarding the structure of the placenta, for it is apparent that these do not necessarily require that the tufts of the placenta should project into the uterine sinuses. The great extent to which these tufts projected into the uterine sinuses in the impregnated uterus in my possession was chiefly of advantage in enabling me

to examine, under very favourable circumstances, the mode in which the placental vessels terminated, the reflection of the inner coat of the vascular system upon the outer surface of these vessels, and in furnishing a miniature representation of the structure of the interior of the placenta.

Royal Infirmary,
26th November 1840.

Fig 1

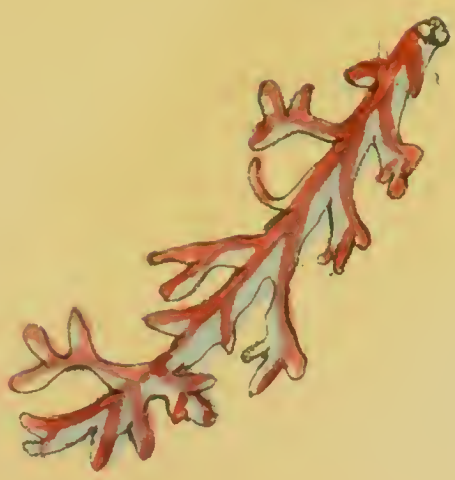


Fig 2

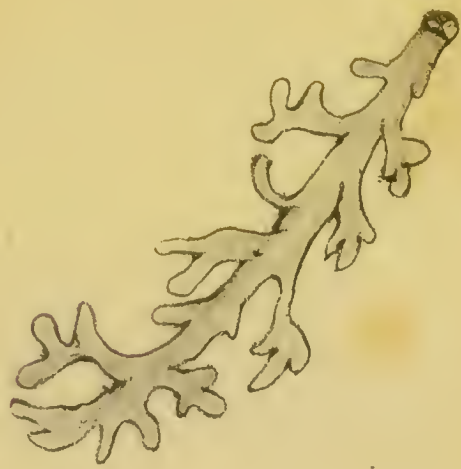


Fig 3



Fig 4



Fig 5

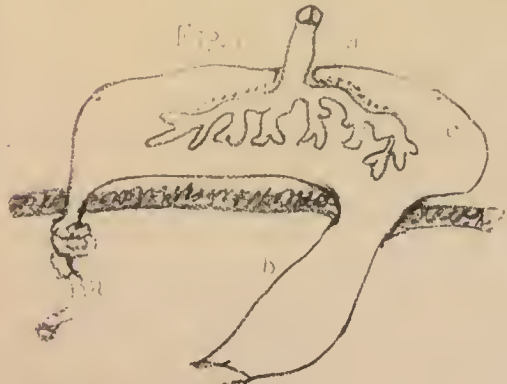


Fig 6



Fig. 1



Fig. 2



Fig. 3

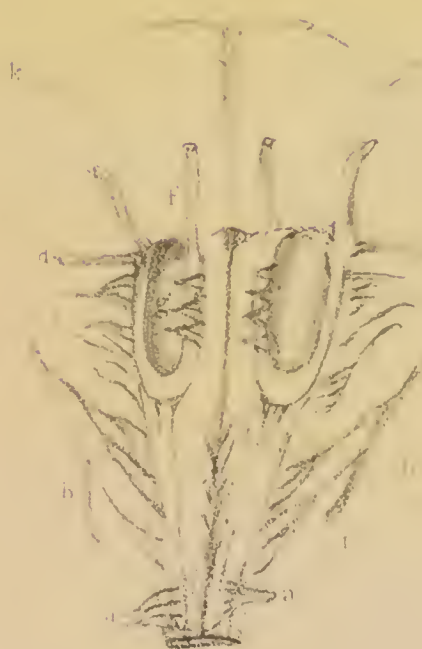


Fig. 4

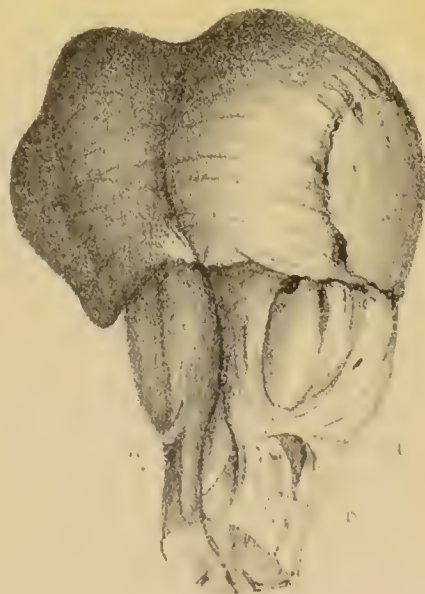


Fig. 5

